JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 18 MARCH 19, 1928 No. 6

PALEONTOLOGY.—*Prehistoric ornithology in North America.*[1]

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When one considers that the number of forms of living birds known at the present time is approximately 25,000, the fossil species that have been discovered are remarkably few. The most recent synopsis of the fossil birds of the world, that of Koloman Lambrecht, published in 1921, includes only 700 species, part of them of doubtful identity; the list has been increased slightly in the seven years that have passed since this publication. At the present date there have been described 154 species known only as fossils from that part of continental North America which lies north of Mexico (but including the peninsula of Lower California), this being the area included by the American Ornithologists' Union in its official Check-List. To complete the roster of fossil forms for this region we must add 105 species now living whose bones are found in deposits of Pleistocene age, so that the list includes at the present moment 259 names. The total is less than that for any other group of vertebrates except the amphibia for this region. The fossil reptiles according to data supplied by Dr. O. P. Hay, now number 1011, or nearly four times the number of birds, while the amphibians (without reference to supposed members of this group named from tracks alone) reach a total of 156.

That comparatively few students have taken up serious work on our fossil birds may be due to three factors: first, the small numbers in which fossil bird bones ordinarily occur; second, the incompleteness of the specimens in most cases; and third, the lack of skeletal material in most museums for comparative use.

[1] Presidential address delivered before the ACADEMY January 10, 1928. Received January 26, 1928.

It is true that there have been occasional deposits in Pleistocene beds in North America where bones of birds have been found in great abundance, as at Fossil Lake in Oregon, and in the pitch deposits at Rancho La Brea in California, but these are exceptional both in number of individuals and in range of species represented. Ordinarily the careful collector of vertebrate fossils finds no bird remains whatever, or at most recovers only a few fragments in the course of a season's explorations in the field. Most of these are secured incidentally in other excavations, the majority of bird bones being small and easily overlooked, or of such form as to offer little promise, so that when only partially exposed they may be disregarded by the searcher for striking specimens.

Bird remains in the fossil beds below the Pleistocene are characteristically fragmentary or broken. Leg and wing bones are those most usually encountered, with occasional parts of vertebrae, pelves, sterna or ribs. Seldom are more than the merest fragments of skulls secured, and on relatively few occasions have complete skeletons been found.

Birds as individuals exist in enormous numbers, and as there is naturally a constant mortality among them it might be expected that their remains would be abundant. There is no reason to suppose that birds were less common during the Tertiary than now; in fact there is ground to believe that they may have been more numerous prior to the Recent Period than in the present century. Our present race of civilized man was not then developed to trouble them: and there is no question but that the rising dominance of man in the last hundred years has had far reaching effect in reducing the total numbers of birds, both by his personal activity in hunting, and by the changes in ecological conditions that have attended his agricultural and commercial developments. Many of our existing species are now able to maintain their living status only through restrictions arranged for their benefit by those far-sighted persons who realize the necessity for conservation in connection with our remaining wild creatures.

It would seem then that in previous geologic ages there may have been more birds present in North America than exist today. That few seem to have been preserved as fossils is apparently due to the fact that the bones of birds are so light that they are easily destroyed. Most of the limb bones have a hollow center, with comparatively thin walls of dense, rather brittle structure, and when subjected to undue pressure are crushed or broken. Most birds die through capture by some predator, or if overtaken by disease are eaten promptly by some scavenger. As the majority are of small or medium size they are often

entirely consumed, and their bones comminuted or destroyed by the strong digestion of the creature that has found or captured them.

That this destruction is the usual course when birds die will be attested by field naturalists when they reflect upon the hundreds and thousands of living birds that are seen and the relatively small number of instances in which remains of dead birds are encountered. Armies of predatory or scavenger creatures, many of them unnoticed by the average individual, destroy the carcases immediately upon death.

The bones that in past ages through fortuitous chance have escaped this destruction are frequently of little moment to the paleontologist. Bones of the toes, ends of the ulna, broken bits of the coracoid, or fragments and slivers from the shafts of long bones, all of which are common as fossils, ordinarily offer no distinctive characters, and, in the main, should be disregarded by the careful student. Unfortunately through the enthusiasm of early workers in the science these have served frequently as the basis of description for names that are now stumbling blocks in modern paleontological studies.

In work in the field I have been interested in observing the skeletal remains of birds, and have found that chance today seems to favor the preservation of exactly the same type of fragments as those found among Tertiary fossils. The body of a duck or a heron is eaten by some coyote or vulture which tears out the breast and the viscera, destroying part of the sternum, breaks the skull to obtain the brain, and mangles the wings and thighs. The remaining portions dry somewhat, and the flesh is removed either fresh or dried by the work of insects. The broken skeleton is light, and unless anchored by vegetation, blows about with the wind or is swept by running water. Bit by bit if falls apart and is scattered over the space of several square feet. Occasional bones are buried in such a way that they may be subject to decay, or, less often, where they may be preserved. Even where vertebrate scavengers are not active delicate portions and many of the more sturdy bones disappear.

Imperfect preservation is common where predatory enemies are absent. On the islets in the Hawaiian Bird Reservation thousands upon thousands of birds of moderate size live without interference from the usual enemies that prey upon birds in continental areas. It might be expected that here complete skeletons would be preserved in large quantity since there is the usual regular mortality among the assemblage. I found, however, that even here the carcases disintegrated while the thinner parts of skulls, sterna and pelves, under the combined effect of sun, rain, and wind-blown sand, were corroded

away, and the firmer bones were scattered by violent gales. On Laysan Island many found a resting place in the concentrated saline waters of the shallow, central lagoon, and here on investigation I found a veritable cemetery of bird remains, mostly composed of the long bones, characteristic of fossil deposits. These thousands of fragments were being steadily buried in the sands that blew in upon them so that the lagoon at Laysan may be a possible source of fossil deposits for study in the remote future if then there still exist beings interested or capable in such research. The situation on Laysan suggests that similar conditions have operated on many oceanic islands, and that there is opportunity for discovery of extinct forms of life when these are found and properly exploited. Formation of such large deposits seems to occur only under exceptional circumstances, it being more usual for only scattered fragments to be preserved.

The certain history of the class of birds as known in North America at the present time must be considered to begin with the Cretaceous period of geologic time. It is true that there is one species called *Laopteryx priscus*, described by Marsh from the Morrison formation of southern Wyoming, that in late years, without particular reason, has been listed in the same family with *Archaeopteryx* of the Old World. As there is, however, some doubt that *Laopteryx* is actually avian, its systematic position must be considered vague until it has been more carefully studied. Another fragment, described by Emmons in 1857 as *Palaeonornis struthionoides*, from what are considered possibly Triassic beds in North Carolina, is also so doubtfully avian as not to merit consideration at this time.

The first fragment of a fossil bird from this continent of which we have record, a part of a tibia, was secured by S. W. Conrad in Cretaceous marl beds near Arneytown, New Jersey. This was mentioned in 1834 by Dr. Morton in his "Synopsis of the Organic Remains of the Cretaceous in the United States," as a species of *Scolopax*, but was not actually described until 1870 when Marsh bestowed upon it the name *Palaeotringa vetus*.

The birds found in the Cretaceous period of greatest interest are species known to have teeth, first described from specimens found by Marsh and parties under his direction in the Niobrara beds of western Kansas. Of prime importance among these are the members of the family Hesperornithidae, in which there are at present recognized five species. Several practically complete skeletons have been discovered so that in spite of their antiquity these fossil forms are fairly well known. The species of *Hesperornis* were diving birds with

greatly elongated bodies, strong legs, paddle-like feet, and long necks, with the jaws set with sharply pointed teeth placed in continuous grooves. The vertebrae were saddle-shaped like those of modern birds. The lower jaw had teeth set along the entire length, but in the upper jaw teeth were placed on the maxilla alone, the premaxilla being smooth, so that apparently even at this remote date there began a tendency to tooth reduction which has resulted in the toothless jaws found in modern birds. The various species of *Hesperornis* lived in the shallow seas that covered parts of the interior of our country in the Cretaceous, and from their form seemed to have fed on fish which they captured by diving. They were so adapted for aquatic life that they had entirely lost the power of flight. In fact the wing is known from the humerus alone which is reduced to a slender, curved stylus, the head of which has so slight an articulation on the scapular arch that it is evident that it had little function. It is possible that the remaining wing elements were represented by rudimentary bones but these have not been identified, and if present at all they must have been very small.

Early constructions of the skeleton represented *Hesperornis* in an upright attitude, but on more careful examination of the articular surfaces of the leg bones it was found that the legs projected at right angles from the body so that it is doubtful if the bird could stand on them at all. It appears that *Hesperornis* presented the most highly specialized developments for aquatic life of any bird yet known. It travelled through the water by propulsion of its tremendously powerful feet, which are of such form and have such size in relation to the remainder of the skeleton that it is probable that at need the bird could develop the speed and agility in turning found in the modern shark or porpoise. On land, if it ventured at any time on terra firma, it must have progressed like a hair seal, prostrate on the breast; it is possible that it built a nest of floating vegetation in the water like the modern grebes, and seldom if ever did more than flounder out on shore to rest in the sun. If its eggs were placed on shore they must have been deposited near the water's edge like those of loons.

Marsh, deceived by the flat sternum, on which there is no keel for the attachment of flight muscles, characterized *Hesperornis* as "a carnivorous, swimming ostrich" while later authors have considered it as perhaps ancestral to the modern grebes and loons. In point of fact *Hesperornis* is so highly specialized that it is doubtful that it may be considered ancestral to any modern form other than that it represents a type of bird that lived at an earlier age. Resemblances to

Hesperornis seen in modern species appear to be merely those characterizing birds as a group, or are the preservation in a few of ancient characters which in the Cretaceous may have been developed in all forms of birds.

The second type of toothed bird, described from the Cretaceous by Marsh, is *Ichthyornis*, a genus in which seven species are at present recognized. *Ichthyornis victor* and *I. dispar*, the two that are best known, in body were about as large as a domestic pigeon. The neck was long, and the head was large and strong, with long jaws implanted with many small, sharply pointed, recurved teeth set in sockets. The wings were large, long and strong, the sternum heavily keeled and the legs and feet comparatively weak. The biconcave vertebrae, which have the form found in fish and some amphibians and are unlike those of any other bird, were the most peculiar feature of the group. *Ichthyornis* was entirely different from *Hesperornis* in that it was pre-eminently developed for flying. That it flew by feathers, and not by means of a skin membrane as do bats, is shown by tubercles for the attachment of secondary feathers on the ulna, and the ankylosis of the metacarpal elements into one bone to form a firm support for the primaries, the long wing feathers on the outer part of the wing. As a flying form it is apparently nearer the central stem from which has come our modern birds than is *Hesperornis*. *Ichthyornis*, however, shows primitive tendencies in that it still carries the amphicoelous or biconcave type of vertebral articulation, so that it combines the ancient with the new, as a grandmother may don the dress of a modern maiden. *Ichthyornis* has been postulated as ancestral to modern terns or skimmers, but here again I believe that resemblance is merely convergent due to the restriction placed by method in flight on the evolution of bodily form in birds. It is my belief that birds of the Cretaceous had as varied form as those of modern times, and that there is no direct linear connection between the few fossils of this time yet known and existing groups.

Certain other Cretaceous fossils, (*Apatornis celer*, and *Baptornis advenus*) from the Niobrara beds, are placed among the toothed birds. There have been described also from the Cretaceous of New Jersey three species of a genus known as *Palaeotringa* that are currently located in the modern family Scolopacidae which contains the snipes, and three more of the genus *Telmatornis* that are allocated in the family Rallidae among the rails. Another, *Laornis edvardsianus*, is considered as an anserine bird of the family Anatidae, or ducks, geese and swans. It is very probable that none of these has anything to do with

the existing families in which they have been grouped, and that all should be placed lower, near *Hesperornis* and *Ichthyornis*. From the evidence of the two genera last mentioned, the only forms in which the jaws have been found, it would appear that teeth are a character to be expected in all ornithic forms of the Cretaceous, and that we should not, therefore, put any Cretaceous bird in a modern family unless its skeleton is completely known.

With the beginning of the Tertiary there is a sudden change in our known fossil avifauna. Toothed birds have disappeared, and the forms found are more like modern types so that the greater number of the approximately 25 species of fossil birds that have been described from the Eocene of North America are now placed in modern families. It may be said that a number of these have been named from very inadequate material and that some, perhaps, may not be birds, as the bones from which they have been described are so fragmentary as to make it difficult to decide whether they belong in the class Aves or elsewhere among the vertebrates. Others on further study may be found sufficiently peculiar to warrant their separation as distinct from living families.

Diatryma steini from the Lower Eocene (Lower Wasatch) of Wyoming is one of the few fossil birds found that is represented by a nearly complete skeleton. This great bird stood nearly seven feet in height and was developed for a terrestrial life. It possessed strong legs, and a heavy head, with a great, arched bill, and very small, almost aborted wings. Superficially it suggests the remarkable *Phororhacos* of Patagonia, and probably was similar in habit. It has been described fully by Matthew and Granger but has not been carefully studied so that its exact affinities are uncertainly known. It is placed at present near the cranes and rails, but does not seem to have very close affinity with either.

Another form that is known from a nearly complete skeleton is *Gallinuloides wyomingensis* from the middle Eocene (Green River) of Wyoming, a gallinaceous form, typical of a special family related to the curassows and guans, fowl-like birds that live among the branches of trees. *Minerva saurodosis* of the same age is apparently a primitive owl, while *Presbyornis* is a shore-bird placed in a separate family from any of our modern species. It seems to have resembled an avocet but probably was more aquatic and swam more readily. *Nautilornis* was an auklike form that differs from modern auks in that it seems adapted for wading as well as for swimming. Other

species that have been described from this age are so fragmentary as to be uncertain in character.

Bird remains from the Oligocene of North America are as yet few so that to date only six species have been recorded. Two of these, a cormorant, and a supposed pheasant named by Shufeldt, are of uncertain status. The only important deposit of this age that has yielded much bird material to the present is one in Weld County, Colorado, where collectors from the Colorado Museum of Natural History in Denver, in exhuming great series of such mammals as *Trigonias, Symborodon* and *Archaeotherium,* have uncovered a few bones of birds. From these the speaker has recently described four species representing peculiar genera not known in modern times. *Phasmagyps patritus* is a vulture related to the living black vulture but about one half larger. *Palaeogyps prodromus,* in the same family, is more like the California condor but is only two-thirds as large, *Palaeocrex fax* is a large gallinule, apparently between two and three feet in height, and *Bathornis veredus* is a species of the shore-bird family of thick-knees or Œdicnemidae. *Bathornis* was peculiar in possessing a hind toe which is missing in living representatives of the family. Further species of extinct birds from the Oligocene will be awaited with interest since in this age we may expect the earliest species that are at all closely similar to those living today.

The 23 birds certainly allocated to the Miocene include a considerable variety of forms. In Colorado, in the deposits known as the Florissant lake beds, famous for the insect and plant remains that that they have produced during the past fifty years, there have been found remains of several birds. A plover has been described as *Charadrius sheppardianus,* while another species, a perching bird about as large as a cedar waxwing or bluebird, has been named *Palaeospiza bella* by J. A. Allen. During a recent examination of the type of the latter species I found that it is representative of a peculiar family to be known as the Palaeospizidae, which belongs near the base of the oscinine subfamily of the perching birds, immediately above the larks, or Alaudidae.

Another avian species from these same Florissant beds has had a curious history. In 1883 the paleobotanist Lesquereux named *Fontinalis pristina* from a specimen that he thought was a bit of a fossil moss. In 1916 Knowlton called attention to this species indicating that the fragment on which it was based was not a plant, but was in reality a bit of a feather. *Fontinalis* must, therefore, be trans-

ferred to the avian list where it is placed in the group of *incertae sedis* without hope ever of ascertaining its proper relationships.

Among other Miocene fossils there have been found in the beds of diatomaceous earth at Lompoc, California, a number of birds from which Loye Miller has described six species, a shearwater, three gannets or boobies, an auklet, and a shore-bird. These occur as flattened impressions or silhouettes in beds of nearly pure diatomaceous material. The birds found are mainly fish-eaters that may have come to a shallow Miocene bay to feed on myriads of herrings whose remains abound in the same beds. The most abundant bird is *Puffinus diatomicus*, a shearwater allied to the living blackvented shearwater. *Limosa vanrossemi* is a godwit much like the modern marbled godwit. *Sula willetti*, a booby somewhat like the living red-footed booby, is of interest in that it shows the same type of closed external nostril found in modern Sulidae, indicating the great antiquity of this character. The bone in these specimens has been so altered that on exposure to the air it crumbles and disappears, leaving only an impression that in turn is evanescent, as the material in which it is formed is soft and friable.

The Miocene of the Sheep Creek and Snake Creek beds of northwestern Nebraska under exploration by the American Museum of Natural History, Princeton University, the Carnegie Museum, and Mr. Harold Cook, has yielded a fair number of bones of birds from which I have described seven species, including a hawk, *Buteo typhoius*, related to the modern red-tail, two small eagles, *Geranoaëtus ales* and *G. contortus*, of a genus not found outside South America in a living state, and a kite, *Proictinia effera*. There is also a peculiar limpkin, *Aramornis longurio*, and a small paroquet, *Conuropsis fratercula*, allied to the modern Carolina paroquet but smaller. One may picture the area as a badlands section where hawks and eagles, with nests on the sides of cliffs, dropped the bones of their prey on the slopes below, to mingle with occasional bodies of the predatory birds that had brought them to the place.

The Pliocene, like the Oligocene, has fossil birds poorly represented as yet, as at present we know only 10 forms from within the limits of this age. The upper Snake Creek in Nebraska, which is placed in the lower Pliocene, has given us an eagle, and a species of chachalaca, *Ortalis phengites*, a tree-haunting, gallinaceous bird of a group not found today north of the lower Rio Grande Valley. From these same deposits within the last few weeks I have received the humerus of a

crane that is seemingly identical with the existing sandhill crane, the first instance found of remains of a species still living below the Pleistocene. From beds ascribed to the Upper Pliocene in southern Arizona I have identified a small goose, *Branta minuscula*, a tree duck, *Dendrocygna eversa*, a sandpiper, *Micropalama hesternus* and a dove, *Chloroenas micula*.

Though a part of the birds of the Miocene and Pliocene are peculiar many are identified in genera existing at the present time. It is my own belief that these two ages mark the period of evolution of our modern genera of birds and that there has come comparatively little change in generic type since. In my opinion evolution among birds during the Quaternary has been concerned principally with the development of those differences that characterize species and subspecies, differences which in some cases have been so pronounced that present usage, with its close perception of minutiae, concedes them as generic. When broad, comprehensive limits are given generic groups, however, these seemingly have had their origin in the latter part of the Tertiary.

It seems probable that the bird life of the Miocene and Pliocene was even more varied and wonderful than that of today, and that a larger number of species may have existed. We are told that climatic conditions in that time had not developed such sharply marked zonal characteristics as in the Recent period, so that though the temperature was not oppressively warm it was moderate and fairly uniform at points much farther north than under modern conditions. Forms that we consider now as subtropical, in the Miocene and Pliocene ranged north into northern Nebraska, and probably further. We are aware that the present number of species in tropical and subtropical sections of America is much greater than in the temperate zone. Ecuador for example, in the geographic limits at present granted to it, has approximately the same area as the State of California. The known bird life of Ecuador at the present time numbers 1508 forms, more than for the whole of North America north of Mexico, while that of California at the end of 1924 (the latest published revision of the list) included only 594 species and subspecies. By analogy we may suppose a rich and highly varied bird life for the Miocene and Pliocene periods in North America, a fauna that since has been in part exterminated and in part restricted to more southern latitudes. Further research may be expected to increase considerably the list of fossil forms known from this section of geologic time.

With advance into the Pleistocene we come to an age in which the fossil avifauna becomes much better known through more numerous occurrence and greater abundance of specimens. Fifty extinct species have thus far been described from our Pleistocene beds, evidence of a rich avifauna. There are in addition 105 species of birds still existent whose remains have been identified in Pleistocene deposits, so that the entire group for this period includes 155 forms of birds, more than half our present list, and a considerable number when we consider the smaller figures yielded by our census in previous ages.

It may be remarked parenthetically that the fifty extinct species that have been described from the Pleistocene are definite indication of what has been said above of the probable abundance of birds at the close of the Pliocene, since these forms undoubtedly had their evolution prior to the Ice Age and were in existence at its beginning. From somewhat meager information I am inclined to regard the close of the Tertiary as the period of greatest diversity and abundance in bird life in the earth's history so far as North America is concerned, and to believe that with the rigors of climate incident to the opening of the Pleistocene, and the even more unfavorable conditions of the historic part of the Recent Period occasioned by the increase of man over the earth, there has been steady reduction and extermination among birds, a process that will continue in spite of protective regulation until most of the peculiar forms have disappeared and only the more adaptable ones remain.

To return to our Pleistocene avifauna we find several deposits that have yielded abundant bird remains. The earliest known of these important beds was that of Fossil or Christmas Lake, in the arid section of Oregon, where deposits containing hundreds of bones of birds have been explored. These, studied first by Shufeldt and later by Miller, have given a varied list of birds, mainly aquatic, of which a number have been described as species distinct from those existing today, and many have been identified as identical with living forms. Dr. O. P. Hay considers the age as first interglacial. Of the more than twenty peculiar species only one, *Palaeotetrix gillii*, is now held to be generically distinct from living birds. The flamingo, *Phoenicopterus copei*, is the most unusual species in the assemblage, as any of the other genera might be expected in this area today. It may be remarked that the flamingo is no criterion for particularly warm climate at the time mentioned, since a somewhat similar species of flamingo now ranges and nests in South America through Patagonia where the summer weather is often cold and inclement.

The deposits of bird bones from this Oregon locality are found in an old lake bed that from modern conditions might be supposed to be similar to the small alkaline lakes now common in this area. If this is true it is possible that the great abundance of bird remains is indicative of a condition in the Pleistocene similar to one that has destroyed hundreds of thousands of waterfowl in the western part of the United States in recent years. The malady to which I allude, the so-called "duck sickness," has been especially prevalent in the past twenty years in the deltas of streams flowing into Great Salt Lake in Utah, but is known in alkaline lakes in a number of other sections, including the Malheur region of Oregon. Briefly, it appears that birds, principally ducks and other aquatic species, become affected by excessive concentrations of alkalis in the waters in which they feed, and unless they can have immediate access to fresh water they become paralyzed and die. Aquatic birds of various kinds have been affected and the number of individuals known to have been thus killed in the last twenty years has been tremendous, running literally into the millions. The possibility of the accumulation of extensive deposits of bones of birds that may be preserved as fossils under these conditions is easily evident.

The most famous deposit of Pleistocene vertebrate remains in the New World is that of Rancho La Brea on the Californian coastal plain only a few miles from the business center of the city of Los Angeles. Here outpourings of asphalt from the depths of the earth have been exposed in such a way that they have served to entrap animals which were held in sticky embrace until death came to them, and then when decay had released their skeletons, to entomb the bones in a bed of tar where many have been preserved in perfect condition. The manner in which this pitch trap operated is seen in minor deposits that form today, as it is not unusual to find small mammals or birds held fast in the viscous substance. Under careful exploration the beds at Rancho La Brea have yielded bones to an aggregate of many, many thousands and have included very large numbers of remains of birds. To the present time Loye Miller has published identification of nearly sixty species, and there are unquestionably others to come as the smaller forms, the passeriform or perching birds in particular, have not yet been carefully studied. Two-fifths of the forms from these deposits are extinct. Such scavengers as vultures, which would be attracted to the bodies of dead animals, are represented in abundance, and include several extinct genera. Among these the most curious is the

great *Teratornis merriami*, which is known from almost the complete skeleton, and represents the largest of flying birds, exceeding in wing spread the modern condors. Another species of great abundance was a gallinaceous bird, *Parapavo californicus*, supposed at one time to be a peacock, but now admitted as a species of turkey. The age of these deposits is placed by Hay as first interglacial.

Asphalt deposits of similar kind have been found recently near McKittrick, and near Carpinteria, California, giving additional information on the distribution of the avifauna of California in the Pleistocene, which, in its abundance of vultures and large hawks and entire lack of gulls, offers a decided contrast to that of Oregon.

Recent explorations in Florida, near Vero and Melbourne, in what are supposed to be Pleistocene beds, have yielded remains of birds in which are found the great stork known as the jabiru, and various other species. Recently a valuable collection gathered by Mr. William W. Holmes near the west coast has come into my hands for study, and on preliminary examination is found to contain a considerable variety of species. Most remarkable is a broken metatarsal of a male turkey with a trifid spur core that may represent an unknown species. Multiple spurs are known among certain pheasants, but have not been recorded among the gallinaceous birds of North America. The Holmes collection when fully identified will add considerably to knowledge of the ancient Floridian avifauna.

Cave deposits that have been explored in California and also in Pennsylvania and Maryland have contained remains of Pleistocene birds, that need not be described in detail except to remark that such offer a fertile field for investigation.

The discovery of additional forms in the Cretaceous is uncertain but if obtained will be important. At the present time only two types are well known from this period, one of diver form, and the other of flying habit that apparently fed on the wing over water. These are both so specialized that we may expect that other toothed birds existed though their possible presence is now indefinitely indicated by fragments of a few waders or marsh inhabitants. The Tertiary should give many more species than now known, particularly in its Miocene and Pliocene beds, and finally from the Pleistocene we may expect many forms in addition to those already discovered. From cavern and other deposits we may hope for more extinct species related to modern birds, some peculiar and some with relatives living today in South America.

It has been already intimated that the number of extinct species of birds from North America is far less than is to be expected. As the forms described by earlier students are passed under review it is evident that much remains to be done to decide their proper status. Many have been named from such insufficient material that their systematic position is doubtful while there are a few in which the type material is a composite of fragments that may contain remains from two or more families so that selection must be made to properly apply the name. Some that have been called birds probably are not avian and eventually will be rejected from our list. Progress is being made steadily in these matters and yearly the condition improves so that our uncertainties become fewer and fewer. Such glimpses as our few fossils give us of the life of the past are fascinating and promise high return for the most painstaking study. At the present rate with which new material comes to hand we may possibly expect to see our knowledge of palaeornithology in North America doubled in the next twenty years.

PALEOBOTANY.—*A petrified walnut from the Miocene of Nevada.*[1]

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There is in the National Museum collections a single silicified specimen of a walnut, which, despite precise data regarding the locality from which it was collected, shows such characteristic features that it fully merits description. The specimen was collected by W. M. Leite, who in July, 1885 sent it to the late Professor Joseph Le Conte, who must in turn have submitted it to the late Frank H. Knowlton, since the original letter bears the following notation in Dr. Knowlton's handwriting: "This is probably a nut of Carya (Hickory)."

Mr. Leite stated that the specimen was collected in the desert along the old emigrant road near the line of the railway, 50 miles east of Reno, Nevada. Hence it probably came from the Truckee beds[2] and is Miocene in age.

The shell of the nut is slightly yellowish on the outside, but very light in color where fractured. Both faces are partially broken away and one of these breaks exposes a complete cotyledon, similarly silicified, but black in color and strikingly contrasted with the enclosing shell.

[1] Received January 10, 1928.

[2] CLARENCE KING. Rept. U. S. Geol. Surv. 40th Par. 1: 412. 1878.